

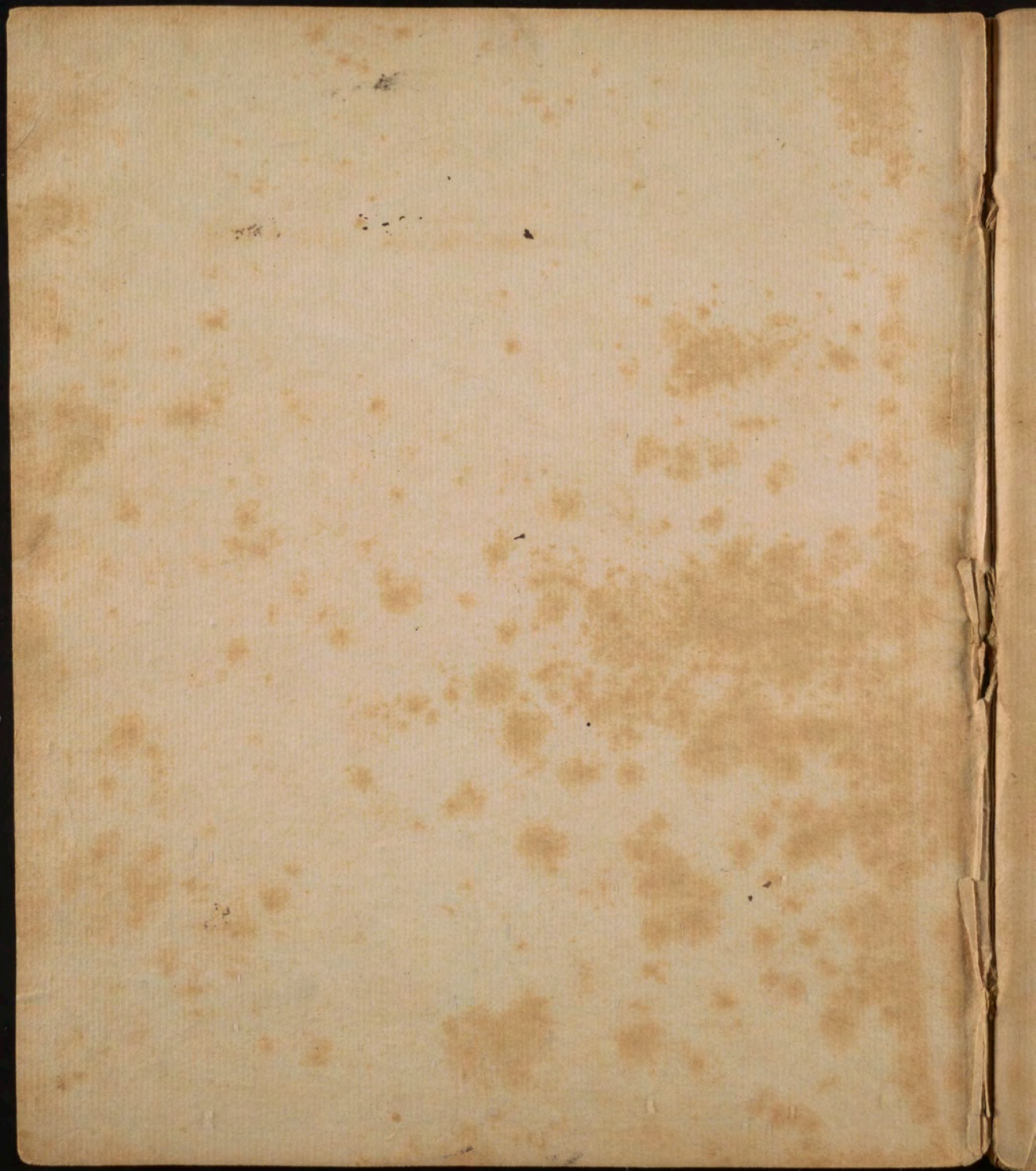
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F 11









of Seeing

To do justice to ~~the subject of~~ this kind,  
 would require a whole course of lectures.  
 - The mathematician & natural philosopher  
 have each in his turn made the  
 theory ~~and~~ of Vision the subject of <sup>investigation</sup> ~~and~~  
 and controversy. [I shall only mention  
 these controversies, and confine myself  
 to that detail of facts & principles which  
~~should~~ should be previously known by a  
<sup>student of medicine</sup> ~~before~~, before he can understand the  
 pathology of the eye ~~and the defects of~~  
~~the sense of seeing~~. —

This ~~is~~ is important



✓ Insects are provided of a number of eyes to defend them from the injuries from all quarters to which from their weakness, they are constantly exposed.

Vision is nearly universal. Some animals exist without it. It exists in the highest degree in birds - next in man - then in the ape - in certain quadrupeds, - & descends gradually to reptiles, insects - and fish.

The size of the eye <sup>is in an inverse</sup> in proportion to the size of animals - It is least in the whale & the Rhinoceros, & the Elephant, & largest in birds & insects <sup>in proportion to the size of their bodies.</sup> The eyes are placed in the human body =

of a cat, highly granular







✓ The Structure of the eye lids, as being the seat of several diseases merits our particular attention. They consist of six coats.

1 The Cuticle which ~~peels off after~~ <sup>peels off after</sup> recovery from the Erisipelas. 2 The true Skin. 3 The cellular membrane. This thin coat <sup>sometimes</sup> swells in the small pox & in Erisipelas to the thickness of an inch. It is sometimes ~~swollen~~ <sup>swelled</sup> in a Dropsy.

It is remarkable <sup>that</sup> in the fattest persons there is never any fat in this membrane.

4 The muscular expansion of the elevator muscle of the eye. 5 a Stratum of papilla.

6 a fine membrane which lies next to the eye - full of small vessels visible upon elevating the eyelids. By means of these numerous membranes, the eyelids ~~the~~ are elevated & depressed without any ~~or~~ <sup>the</sup> wrinkles <sup>is</sup> remarked.



protect the eye from too much light - ~~from~~  
~~from the sweat which distils from the~~  
 brow in labor.

~~the eyes and prevent the entrance of the following~~  
~~also~~ from insects - and ~~from~~ the par-

- ticles of dust which float at all times  
 more or less in the air. <sup>They are called by Dr Haller "Tuta-</sup>  
 -mina Oculi". The eye lashes curl upwards at their extre=  
 -mities.

To facilitate the motions of the  
 eyes, they are provided with a number  
 of muscles which move it in every possible  
 direction, and with a velocity that can  
 scarcely be measured. —

To preserve the softness of the and trans=  
 -parency of the eyes, as well as to facilitate  
 their  
 motions, they are provided with glands  
 of different kinds, some of which secrete  
 an ~~unctuous~~ <sup>unctuous</sup> -  
~~and~~ and others a watery liquor



the <sup>Birds</sup> ~~fish~~ which pass in the air as the  
Eagle &c have a third ~~eyelid~~ eyelid.  
So ~~have~~ nocturnal birds. Fish have  
no eye lids. The water in which they  
swim, weakens the rays of light, &  
serves the purpose of tears.

The Use of the Eye Lids is demonstrated by  
the loss of sleep - pain - inflam<sup>n</sup>. & death  
which follow the loss of them. [Regulus.  
also the Ophthalmia which follows an inability  
to close them from inflam<sup>n</sup>. & swelling.  
Only cured by cutting them so as to reduce  
this swelling by bleeding].



which are poured forth at all times in health, at such times, & in such quantities as they are most required. — 377. Fine

The Coats of the eye ~~are divided into 3 by some, & 6 by other physiologists.~~  
~~have been divided into 3 by some, & 6 by other physiologists.~~  
~~According to the latter division they are~~  
 - the Sclerotica - the Cornea - the Choroida -  
 - the Iris - and the Retina. —

- 1 The Conjunctiva - is a continuation <sup>anterior part of g.</sup> of the Cornea, ~~and~~ It covers the whole eye, and connects it with the eye lids. It is in a sound state always transparent.
- 2 The Sclerotica - forms what is called the white of the eye. - It is a dense - compact membrane extending from the optic nerve to the cornea. It has but few blood vessels, and nerves, & has but little sensibility. Some anatomists



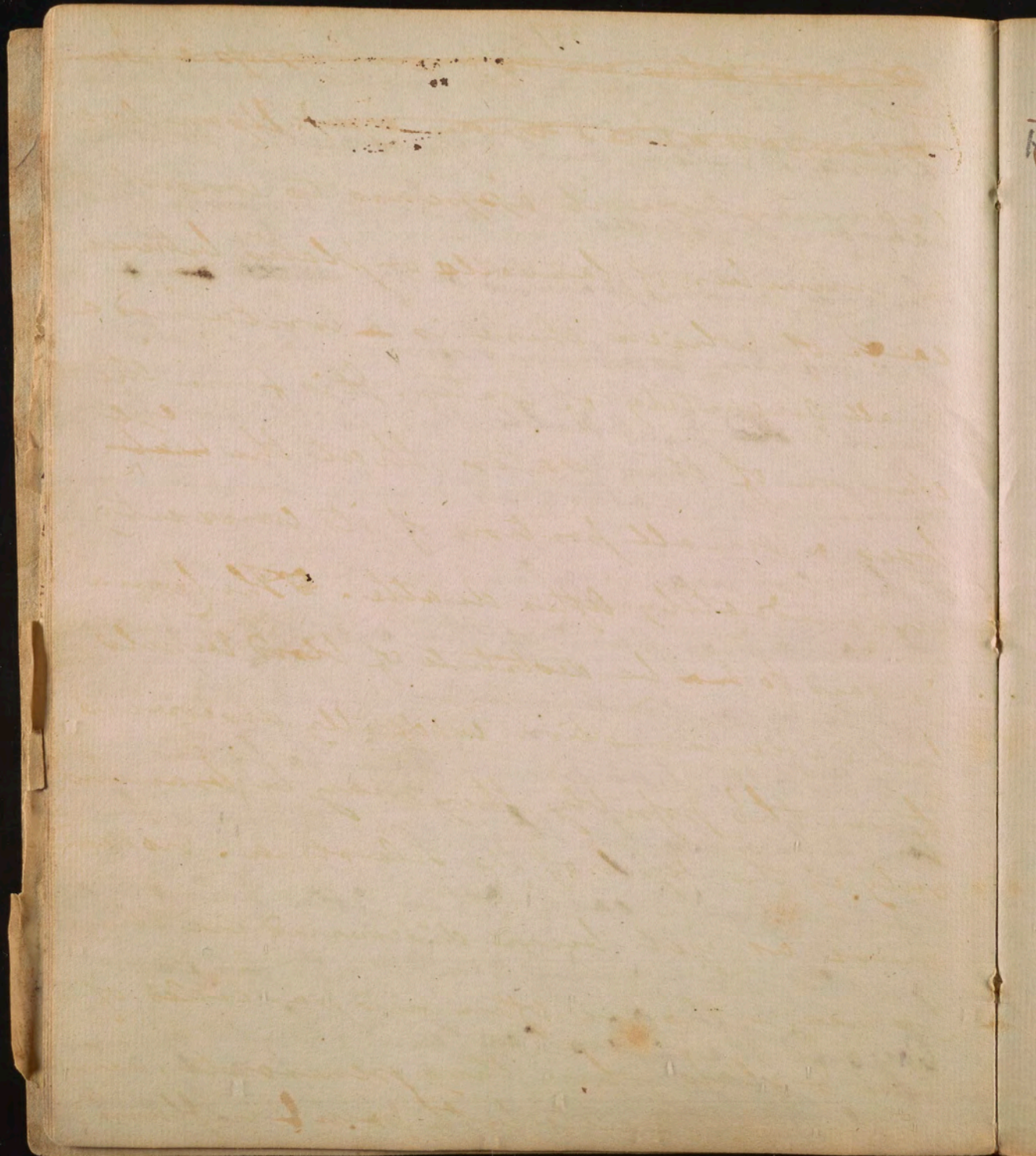




suppose it to be a continuation of the  
 Dura mater, but others with more  
 reason suppose it to be a simple mem-  
 -brane accompanied only ~~with~~ <sup>by</sup> the  
 pia mater continued from the optic  
 nerve. ~~As~~ In adults this continuation  
 of the pia mater has never been discovered.

3 The cornea is placed in the middle of  
 the anterior part of the eye. It is suppo-  
 -sed to be a continuation of the Sclerotica,  
 but Dr Haller has proved them to be distinct  
 membranes by their spontaneous Sepa-  
 -ration from each other, after being mac-  
 -erated in warm water. It ~~pro~~ projects  
 beyond the Sclerotica, and thereby assumes  
 a more convex appearance. ~~for~~







~~different colors in different people, but~~  
~~it is transparent in every eye.~~ Upon close  
 examination it appears to consist of  
 a number of lamellae or plates, between  
 each of which there is contained a  
 small quantity of water. It is from the  
 effusion of this water, that the <sup>eye</sup> ~~head~~  
 loses a small portion of its convexity,  
 immediately after death. The cornea  
 is said to ~~be~~ be destitute of blood vessels,  
 but inflammation evidently discovers  
 them, tho' possibly, they may be branches  
 only of the vessels of the sclerotica. No nerves  
 have as yet been discovered in the  
 cornea, - tho' we often find particles of  
 iron & glass when they penetrate, and  
 adhere to it excite both pain & inflamm<sup>n</sup>.



✓ This membrane or Uvea is covered w<sup>th</sup>  
a black pigment. It is paler in ~~old~~,  
than in young people. - It is of a light  
color in the bat - & in many other  
animals which see best at night. Its  
dark color was intended to serve  
the opposite purpose of  $\frac{1}{2}$  on a mirror.  
= not. It was not to reflect, but to suppr  
= rate rays of light.



4.5 The Choroidea is placed under the Scler-  
 =tica, and is connected with it by numerous  
 intervening vessels. It consists of numerous  
 small Arteries, and Veins. It accompa-  
 =nies the Scleritica to the Cornea where it  
 adheres to the Scleritica by means of a  
 cellular membrane resembling a white  
 fringe & w<sup>ch</sup> is called the ciliary Circle.  
 From this connection, it descends down-  
 =wards & inwards, forming a round disk  
 of which the Anterior Surface is called  
 Iris from its variety of Colors, & its  
 posterior Uvea - or membrana P<sup>u</sup>yschi-  
 =ana. This disk has an opening in its  
 middle called the pupil which is  
 capable under different circumstances



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of contraction & dilatation. ~~The latter~~

The Iris is said likewise to be capable of similar contraction & Dilatation but it is probably papine only - in the contraction & dilatation of the pupil. The Stria which pass from the external margin of the Iris to the pupil are have been supposed to be muscular fibres. - they become straight when the pupil is contracted, & are drawn into serpentine folds when the pupil is dilated. Some late dissections shew the Iris to be flat & not convex &c

6. The Retina is a continuation of the <sup>and</sup> ~~and~~ is medulla from the optic nerve, ~~which~~ expanded into a sphere concentric with the ~~eye~~ tunica choroidea. It is extremely tender, and of a mucous consistence. It embraces the vitreous







humor of the eye, and after extending itself to the ciliary processes it follows their course supported by their arteries, untill it reaches to the crystalline lens to which it is intimately connected.

Lect: 14<sup>th</sup> Decem<sup>r</sup> 27<sup>th</sup> 1791

The humors of the eye are three viz: the ~~aqueous~~<sup>vitreous</sup> - the crystalline & the ~~aqueous~~<sup>aqueous</sup>. It is most proper to call the crystalline a lens. I shall briefly describe them<sup>or</sup>. The vitreous humor <sup>so called from its resemblance to glass</sup> fills the

posterior part of the eye. It is contained in a thin pellucid membrane of a cellular fabric in the intervals of which is contained a clear liquor a little denser than water which entirely evaporates by heat. It is furnished w<sup>th</sup> small blood vessels w<sup>ch</sup> pass thro' to the



+ Its use is to preserve a due softness in the Retina, and to afford support to the Crystalline Lens. —

✓ Its sides are softer than its middle or central parts, — from which it has been said improperly to swim in a watery liquor. This peculiarity in the structure of the <sup>lens</sup> prevents ~~its shape from~~ <sup>its shape from</sup> being completely irritated by glass ~~and~~ in experiments out of the body. For while glass refracts the rays of light alike on its sides & center, the lens of the eye refracts them less on its sides, than its centre, and hence it throws the image further — as to bring it to a focus on the retina. —



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Crystalline Lens. +

2<sup>nd</sup> In the fore part of this vitious humor, <sup>appears the</sup> ~~the~~ crystalline lens is situated, behind the Uvea in an orbicular sinus. This lens is more convex in its posterior, than in its anterior part. It is composed of concentric plates or scales, connected by cellular fibres. Between these plates is contained a pellucid liquor. The innermost plates <sup>of the lens</sup> adhere closest together. The artery, <sup>comes</sup> from the retina thro' the vitious humor. The whole lens is contained in a strong - thick - elastic capsule - of a pellucid membrane - firm on the fore part, and lined behind by the



✓ It is somewhat thicker in its consis-  
-tence ~~than water~~ than water, & less easily  
frozen. It is somewhat brackish to the  
taste, and may be congealed with spirit  
of wine. [I have seen it converted into  
a white mass by ~~the~~ application  
of a strong solution of sugar of lead to the  
eye in an ophthalmia]. It often assumes  
a white appearance in <sup>also in consumptive patients,</sup> old people. Its  
use is, to preserve the pellucidity of  
the cornea. ~~for the~~ Hence ~~we~~ we find  
it present in that coat of the eye <sup>also</sup> - to defend  
the lens & Iris from injuries, & to allow the  
Iris <sup>20 ft</sup> a space to play in. — The external



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Membrane of the Vitreous humor.

3 The Aqueous humor is extremely clear and fluid. It is seated between the Uvea & crystalline Lens, & in the ~~aqueous~~ chamber which lies between the iris and Cornea. It exudes from the small arteries of the iris, Uvea, & ciliary processes. When discharged in couching, or by a wound it is frequently renewed in the space of 24 hours. ✓

Having thus briefly <sup>described</sup> ~~mentioned~~ the Structure of the eye, I should proceed to explain the Nature of Vision, but I shall previously say a few words first upon the Nature of light, <sup>or</sup> ~~as far as it~~ connected with our subject.

Go on to p. 377



Surface of the eye is moistened by a ~~fluid~~  
~~secretion~~ called tears which are constantly  
secreted & poured out from the Lacrymal  
Gland thro' 7. or 8 Ducts which open in  
the inside of the upper eye ~~fluid~~. The  
rapid evaporation of this fluid in hot  
Countries occasions the most distressing  
Ophthalmias - ~~the~~ A Defect of <sup>its</sup> evaporation  
which takes place in wet weather occasions  
involuntary tears. - They become acid by an  
inflam<sup>n</sup> - of the eyes. What <sup>is</sup> not required  
to moisten the eyes nor in weeping is absorbed  
by the puncta lacrymalia, & conveyed into  
the Lacrymal Sac from whence they pass  
~~this~~ into the nasal canal into the nose. ~~the~~  
~~from~~ ~~to be discharged~~ ~~for~~ ~~the~~ ~~tears~~  
~~it is~~ ~~over~~

Turn back to 362"



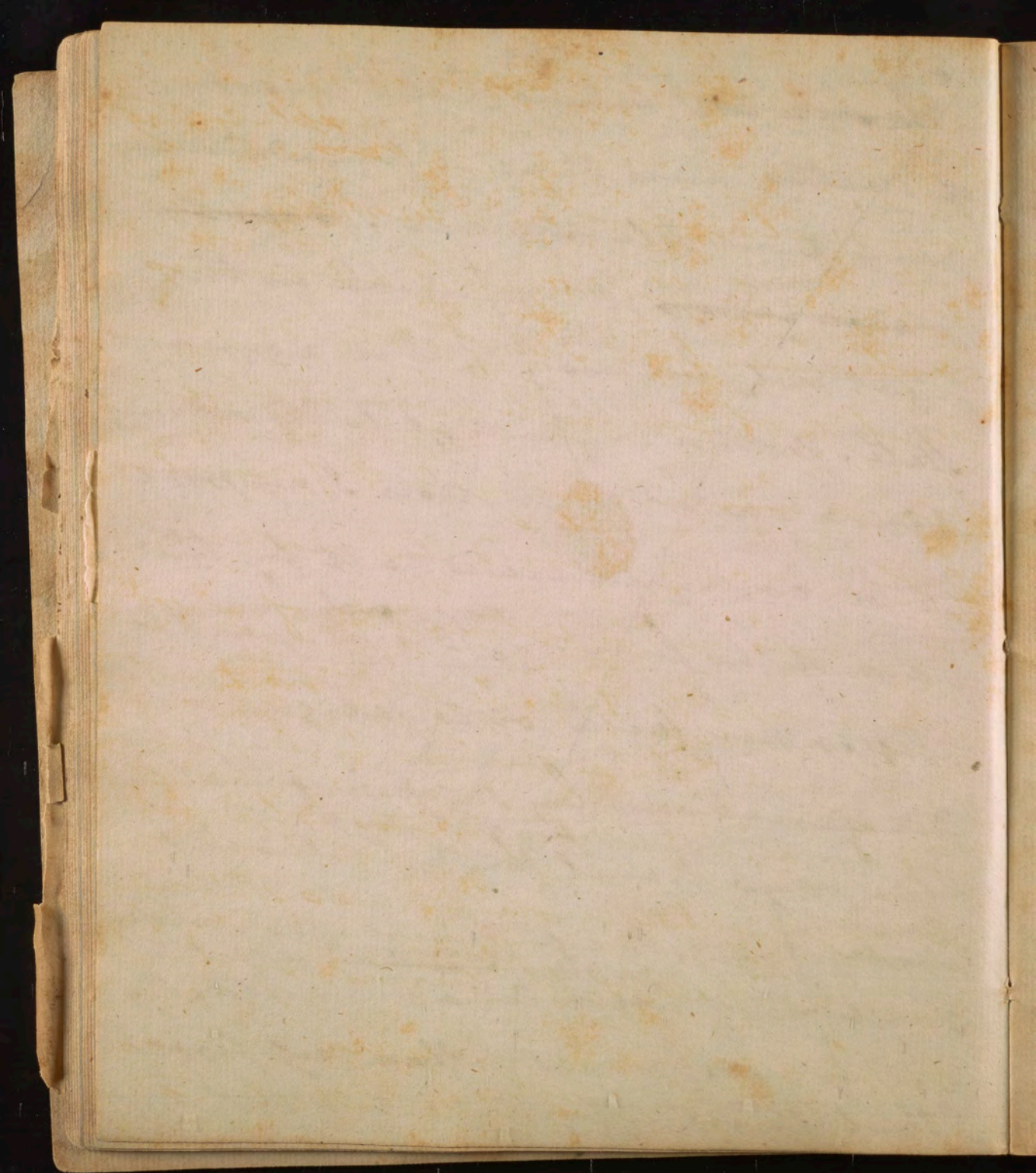
~~The sun is I believe light to consist of matter, and that it produces every part of our Solar system. It ~~app~~ ~~is~~ ~~the~~ ~~source~~ ~~of~~ ~~the~~ ~~light~~ ~~and~~ ~~heat~~ ~~of~~ ~~the~~ ~~universe~~ ~~It is invisible in the night only because it is in a quiescent state. Motion is essential to its producing vision - and~~ to be covered~~

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pp 363-376

rays of the sun. — It is necessary to stagger our faith, or to fatigue our imaginations by supposing that these rays travel <sup>every morning</sup> thirty millions of leagues ~~in 7, or eight minutes, or for~~ <sup>in order to illuminate</sup> our globe. By no means, I would rather suppose that they act by imparting motion







to the particles <sup>of</sup> light which already  
 exist in the air. — In ~~the~~ <sup>explaining</sup> <sub>n</sub>  
 muscular motion I supposed the  
 brain to be the origin of all <sup>motion</sup> ~~various~~  
~~influences~~, but I did not admit <sup>of</sup> <sub>the</sub>  
 necessity of an influx from the  
 brain ~~was~~ in every act of muscular  
 motion. I supposed the matter of  
 the nerves in the extremity of the body  
 which was the vehicle of motion only  
 to be moved by a motion began in the  
 brain, and that the matter which  
 conveyed these motions was stationary  
 in every part of the nervous system.  
 In like manner may we not sup-  
 pose the ~~same~~ <sup>same</sup> with respect to



*[Faint, illegible handwriting in cursive script, likely bleed-through from the reverse side of the page. The text is written in brown ink on aged, yellowed paper.]*



light to be a kind of brain of our  
 Solar system, and that it acts only  
 by imparting motion to those rays  
 which are connected with its substance,  
 which rays by a law of motion for-  
 everly mentioned communicate it,  
 perhaps in less than 7 or 8 minutes,  
<sup>probably</sup> in the twinkling of an eye to ~~every~~  
~~part~~ of our globe. ~~In the~~ But further,

during the repose of the brain - Sensation  
 & motion are every where <sup>the matter & properties</sup>  
~~is~~ ~~every~~ suspended, - but it ~~not~~ ~~still~~ ~~exists~~  
 on which they depend, still exist  
 in the extremities of the muscular  
 fibres. ~~Like the particles of light they~~  
~~are only in a quiescent for like man:~~  
 - now, during the absence (or as our  
 Indian would express it) during the



*[Faint, illegible handwriting in cursive script, likely bleed-through from the reverse side of the page.]*



repose of the sun, the particles of light  
 which are diffused over the surface of  
 the globe, & probably thro' all our solar  
 system are suspended in this operation.  
 - They are deprived of motion, but they  
 still exist, and wait only for the return  
 or fresh excitement of the sun to restore  
 to them the properties of motion and  
 light. - As certain stimuli restore  
 the sensation & motion in the extremities  
 during the repose of the brain, so certain  
 artificial ~~lights~~ <sup>lights</sup> such as fire-lamps -  
 and candles ~~or~~ by ~~restoring~~ exciting motion  
 in the particles of light, supply the  
 absence <sup>within a certain</sup> ~~in given~~ space, of the great  
 sensorium of day and light. -



*[Faint, illegible handwriting in a cursive script, likely from a 17th or 18th-century manuscript. The text is written in brown ink on aged, yellowed paper. The handwriting is slanted and difficult to decipher due to fading and the style of the script.]*



[It would be easy to go on & multiply  
 analogies of the resemblance of light be-  
 -tween the manner in which <sup>it is possible for</sup> light and  
 muscular motion ~~may~~ to be produced.

The Author of Nature seems to have  
 created all things as it were by a  
single instrument, and the further  
 we push our inquiries into the Natural  
 - the Moral - & the intellectual worlds,  
 the more we observe the operations  
 in each of them to be carried on by  
 the same simple principles. E.g. the  
 absence of light is darkness in the natu-  
 -ral - the absence of good is evil in the  
 moral - and the absence of knowledge  
 is ignorance in the intellectual world.



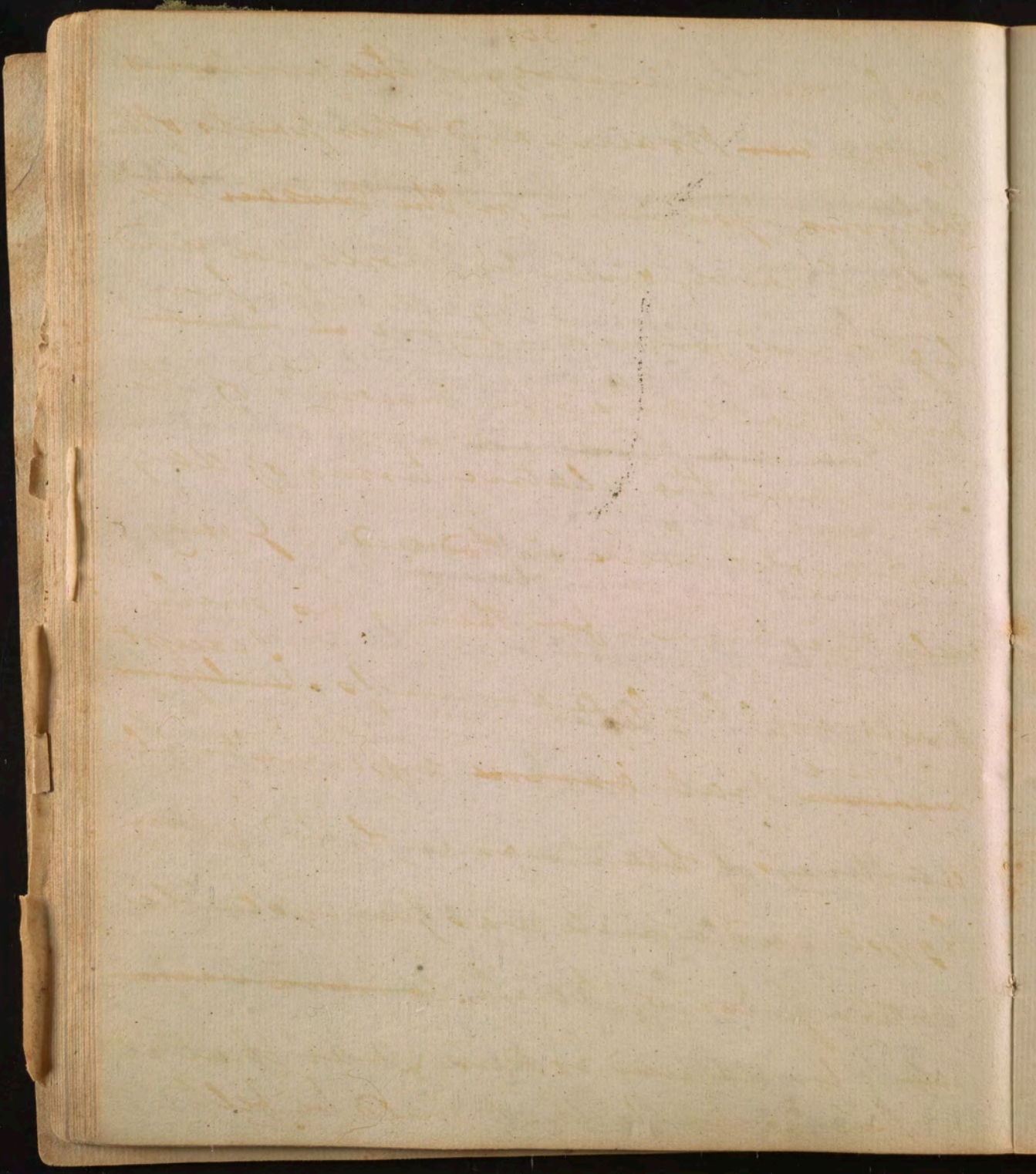
+ Exodus 25. 9. 40. & Numbers 8. 4



Here we observe these great effects to be produced in the same simple manner.

~~All the works of the Creator are full~~  
 of similar examples of Unity, and  
 simplicity appear in all the works  
 of the great Creator. — He seems in  
 the ~~the same manner~~ ~~and~~ works of Creation  
 to have delighted in precedents, or in  
 following his own <sup>sublime</sup> ~~glorious~~ & original  
 examples of perfection. He created the  
 first man — after his own image.  
<sup>on the mount</sup>  
 — and he furnished Moses<sup>t</sup> with a  
pattern of all the furniture of the  
 tabernacle and the altar which he  
 afterwards built in the wilderness.  
 But my theory of light is far from  
 being simply conjectural, or founded







only on the analogy of the functions  
 of the ~~see~~ Brain - and other parts of the  
 nervous system. - In the ~~massive~~ <sup>2</sup> Act.  
 of the Creation given by Moses, we find  
 light was formed - before <sup>the sun,</sup> ~~it was the~~  
 and that it was by means of the  
 sun that the relative terms of day  
 and night were introduced. - I say  
 relative terms - for there is no such  
 thing as absolute darkness, <sup>I except</sup> ~~black~~ <sup>here</sup> ~~we~~  
~~suppose~~ that ~~darkness~~ supernatural  
 darkness which was inflicted upon  
 Egypt and which was perceptible  
 to the sense of touch. ~~to have been~~  
~~it~~, for we read Exodus x & 21 that it  
 was darkness that could be felt.







That light is relative I prove from its existing ~~at~~ during the absence of the Sun. hence we find that certain animals see as perfectly during the night as we do at noon day. We are as yet ignorant of the <sup>lowest</sup> limits of light as we are of the lowest degrees of heat —, for what is call cold, is only a diminution ~~or~~ ~~absence~~ of heat, just as what I called darkness was only a diminution of light. — Allow me another analogy. ~~It~~ Darkness is light in a latent state. It is <sup>converted into</sup> ~~made~~ visible light by a sudden impulse from the sun. — ~~I am the~~ Light then you see Gent: according to my theory depends upon the same







simple cause as animal life viz  
 stimulus and motion. They appear  
 to be ~~the two most active principles~~  
~~the two most active principles~~  
 in the Universe. —

But from where do we derive the  
 relative light of midnight - if light <sup>be</sup> is  
 produced only by an impulse from the  
~~the light~~ -

Sun upon certain particles of light?

~~I answer from the sun and moon~~

I answer, from the moon & fixed stars,

and in the northern Regions from

the Aurora Borealis which is seldom

absent during the long nights of ~~winter~~

those northern Countries. Perhaps too

sometimes analogous to sensation

takes place in the matter of light.



rays of  
✓ Why ~~does not~~ the light which enters  
a dark room by a key hole fill it  
with light? - It only produces light  
on those particles of the matter of  
light which lie in its way. -



when a stick on fire is turned round  
 with a quick hand, it produces in  
 the ~~eye~~<sup>eye</sup> ~~impression~~ a sensation of a fiery  
 circle. This is occasioned by the sensation  
 being continued a short time after  
 the impression has ceased to act upon  
 the optic nerve. <sup>It continues in other instances</sup>  
 In like manner  
~~for~~ minutes. Even half an hour.  
 may not a small degree of motion  
 be left in the matter of light after  
 the sun has ceased to act upon it?

~~say~~ The doctrine which I have  
 offered to you does not militate in the  
 least against the ~~old opinion~~ of the  
 sun being a great body of light -  
 or the ~~only~~ great source of light.







I believe it to be both, but that it  
 produces light in our globe - not by  
 discharging an Ocean of particles to  
 us every day, but simply by setting  
 those particles in motion <sup>on</sup> with <sup>the</sup>  
 the surface of  
 our globe & perhaps our whole planetary  
 system <sup>are always</sup> is filled. —

Does not the feeble and partial light  
 which is produced by artificial means  
 during the absence of repose of the human  
 answer to the sensations & motions <sup>the</sup> w:  
 are excited in the nerves & muscles  
 during the <sup>inspiration</sup> repose of the brain powers of  
 as well as  
 the brain in sleep and in diseases, and in  
 to the sensations & motions which are produced  
 in those animals which are devoid of  
 brains? Does it not show something  
 like a vis insita in the particles or



✓ If this account of the production of light be admitted, it will relieve us from all the ~~difficulties~~ controversy about the demeritation of the Sun by shining. There will be no more occasion to suppose that it ~~loos~~ is loosened by ~~the~~ producing light that than the brain is loosened in its fire or ~~from~~ weight by producing sensation ~~or~~ & motion in the extremities of the body.



matter of light? -  $\sqrt{374}$

~~There is nothing in~~ this theory  
~~more so~~ will receive some support from  
attending to the history of sounds. The  
~~body~~ ~~who~~ sound as I shall say hereafter  
is produced by vibrations or undulations  
communicated to the air by an impulsion  
given to a sonorous body. - Nothing is  
emitted or discharged from this body. It  
does not change its place. It trembles  
only, - and its tremors move successive  
contiguous particles of air as far  
as <sup>these</sup> its tremors extend. Who ever supposed  
the last particle of air that was  
moved came from the sonorous body?  
- Why then should we suppose the



✓ They must all three be resolved into an  
and institution of the Deity.



Matter of light to come every morning  
from the Sun? It is sufficient for our  
purpose if the Sun gives ~~it~~ the same  
motion <sup>to the matter of light</sup> which a sonorous body gives  
to a distant particles of air? —

Do you ask, how motion creates  
light? ~~by changing the figure~~ I shall an-  
-swer it by asking two other Questions.  
How does the brain produce sensation &  
motion in matter? and how does cer-  
-tain tumors in the air produce Sound? <sup>v</sup>

Do you ask how light is altered in  
its ~~direct~~ direction as I shall say  
presently in passing thro' a dense  
medium such as water or glass? I  
answer — just as  
~~as sound~~ <sup>is</sup> sound is altered in  
direction



V You see then gent. that I consider  
light - like life - as an quality, <sup>only,</sup> ~~or~~  
~~can~~ produced ~~to~~ like life by a stimulus  
acting upon a peculiar kind of matter.

-The fun with respect to the matter of light  
~~ours~~ seems to occupy the same rank as  
a primary stimulus, that dephlogisticated  
Air does in producing Animal life.



its course by the form of the Mediums  
 this which it passes, ~~as against its fibres.~~

Do you ask how ~~is~~ are the  
 particles of light reflected from shining  
 bodies - I answer just as sounds are  
 reflected from solid bodies when they pro-  
 duce an echo. — V

But it is time to quit this subject,  
 Perhaps I have only exposed my temerity  
 in ~~expressing~~ <sup>delivering</sup> these opinions upon it - for  
 in so doing I have ventured to oppose a  
 part of his Isaac Newton's ~~invariable~~  
 theory of light. ~~and colors.~~ - You will  
 pardon me if I am mistaken, especially  
 when you reflect that the doctrine I  
 have advanced <sup>is calculated to</sup> ~~to enlarge~~ our ideas of the  
 important uses of the Science of Physiology,



v The

Letter

16

[Redacted]



by shewing us that it may be made  
a key to unlock some of the most obscure  
mysteries of Nature] -

It ~~is not to be~~ <sup>is</sup> fine as this  
matter of light is - it has not escaped  
an analysis. - Sir Isaac Newton ~~has~~  
~~discovered, and by means of a prism~~  
us by means of a prism that  
has taught ~~it~~ it consists of seven  
different species of matter, each of which  
is capable under peculiar circumstances  
of exciting in the mind ~~seven~~ seven diffe-  
rent ideas of what is called color.

These colors are Red - orange - <sup>yellow</sup> green -  
Blue - <sup>Indigo</sup> ~~blue~~ - and violet. - They may easily  
be remembered by taking the initial <sup>letter</sup> ~~word~~ of  
each color invested, and throwing them  
into a word. - This word will be Vibgyon.



all the Variety of Colors in  
✓ ~~Different~~ ~~natures~~ Nature  
Art are produced by different combinations  
of the seven primitive or original colors  
which have been mentioned. The difference  
in the color of any body ~~is~~ depends  
upon its peculiarity of Structure ~~on~~ by which  
it is disposed to reflect one set of rays rather  
~~than another. (You see here that I consider~~  
~~color as a quality of matter. The sensation of it only exists only~~  
~~in the mind, but~~ in the mind,  
~~if there were no vision~~  
and no mind, the substances which reflect all the  
different colors would still have a material existence. The  
opinion was held by Bishop Berkeley  
and many of this opinion  
was ~~refuted by many philosophers~~ who  
especially by those who ~~formed~~ ~~of~~ ~~the~~ ~~philosophy~~



a body is called red when it reflects  
 red rays only - it is called blue, when  
 it reflects blue <sup>rays</sup> ~~only~~ only - and so on  
 of all the other colors. - A body is said to  
 be white - when it reflects all the <sup>species of rays</sup> even  
~~all~~ at once - and black when it ab-  
 - sorbs or extinguishes them all. A body  
 which allows all the rays to pass thro' it  
 is said to be transparent & a body which  
 extinguishes <sup>one</sup> part, and reflects the other is  
 said to be opaque. ✓ go to 383 I have since

When the Rays of light strike a body  
 without entering it they are said to be  
reflected. They strike bodies in different  
 directions, but there is a perfect Uni-  
 formity in this manner of reflection.



~~absurdly~~  
~~I~~ supposed that the matter which excited  
~~all~~ all our sensations had no real qualities  
or shape, but existed only in our minds.  
The sugar - a rose - and the blue color  
of the sky, to have as much a real ex-  
istence as the human body, or a's spirit;  
It is true the sweetness of sugar - the fragrance  
of the rose - and the loveliness of the blue  
expanse of heaven, are all relative terms &  
~~that they could have no existence had there~~  
~~been no organized bodies to~~ <sup>in whose</sup>  
~~senses they could have excited the sensations~~ <sup>percept</sup>  
~~which I have ascribed to them. They possessed~~  
~~a capacity only of exciting pleasure of to return~~  
and ~~require the~~ <sup>concurrent</sup> of bodily senses to render  
them known, but they would have existed with the  
capacity of creating those sensations if a human  
body had never existed to enjoy them. A house  
would have been a house to the end of time,



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Hence ~~the~~ it has been repeatedly demon-  
-strated that the angle of this reflection is  
always equal to their angle of <sup>incidence</sup> ~~reflection~~,  
or in other words, to the angle they make  
~~with~~ in falling upon the body from  
which they are reflected. —

Again - When the Rays of light are  
~~altered or~~ broken in their passage thro' a body, they  
are said to be refracted. This refraction  
appears when the rays enter a body obliquely & is  
~~different~~ different according as the rays  
pass from a thin into a Dense medium,  
or from a dense into a thin medium.

Eg: When they pass from air into water,  
they are <sup>refracted</sup> ~~reflected~~ towards the perpendicular  
drawn in this water to the point of its per-  
-pence where the light falls, - but when they



Although it had never been inhabited, and a  
gun ~~was~~ would have been an instrument  
of death. altho' it never had been employed  
in taking away ~~any~~ <sup>the</sup> life of a single  
animal. This gross error of Dr Berkleys  
~~is~~ is the natural offspring of a belief in  
animal life originating in an impulse given  
to the body by the soul ~~reposed~~ <sup>in</sup> or mind,  
for if ~~it~~ <sup>the mind</sup> be capable of beginning life, ~~and~~ or  
~~possessing~~ bodily existence, no wonder ~~it~~ power  
~~is~~ is given to it of annihilating  
all bodily, or material existences, and  
occupying alone all the ~~space~~ <sup>existence</sup> ~~of the~~  
in form and qualities upon our globe.

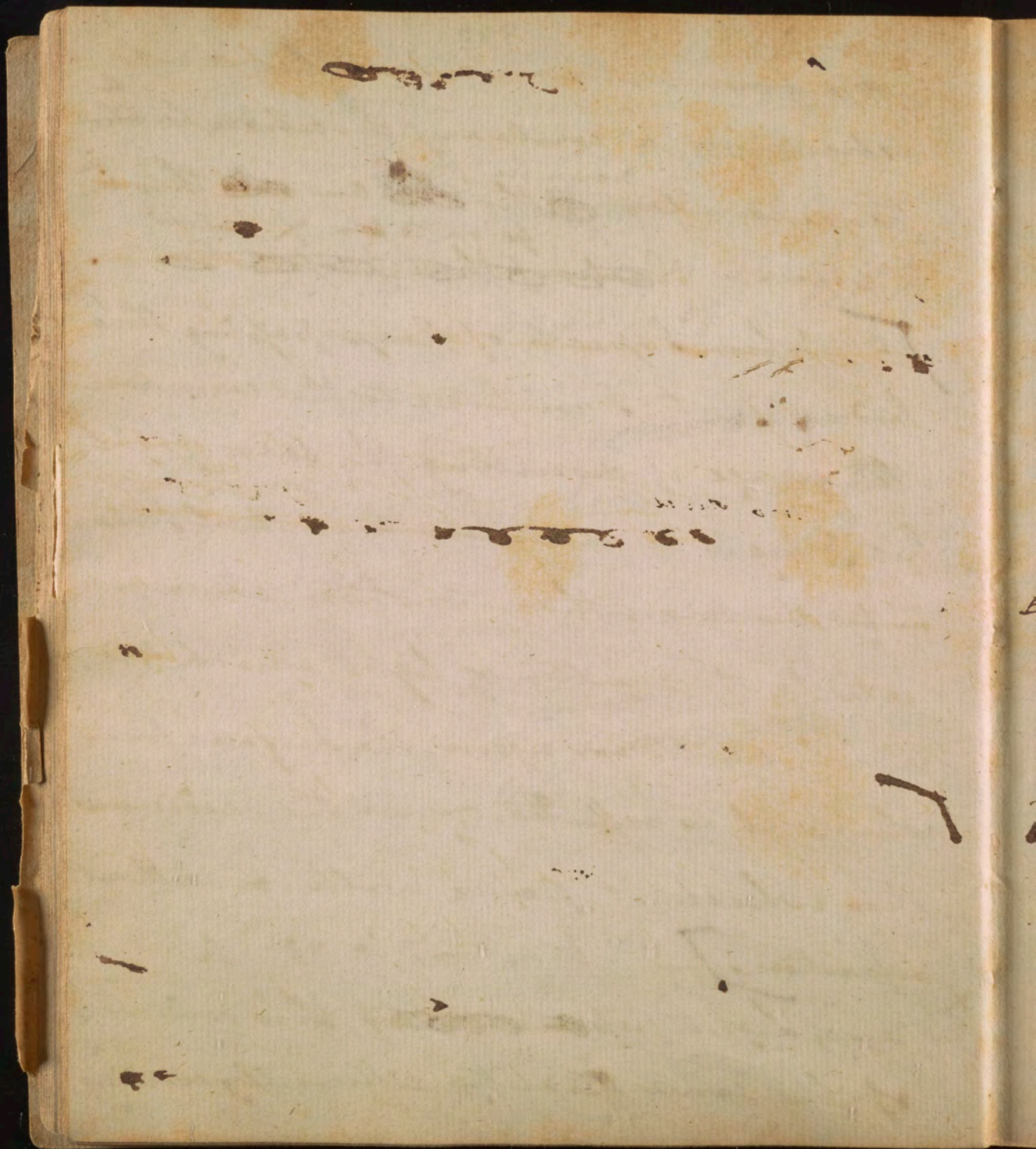


pass from water into air, they are <sup>a</sup> refracted in a contrary direction to the perpendicular <sup>drawn in</sup> the air ~~and~~ this w: it passes. - ~~Go on to p. X below~~

¶ When I speak of Rays passing thro' bodies, &c. I conform to the common language of describing the laws of light, but I beg to be understood here that I mean only no more than motion communicated to the matter of light which previously existed ~~in~~ upon the surface from which it is reflected, or in the medium thro' which it passes with, or without refraction. ¶ turn over to 381. A

× The Rays of light pass ~~through~~ thro' mediums of the same quality differently according







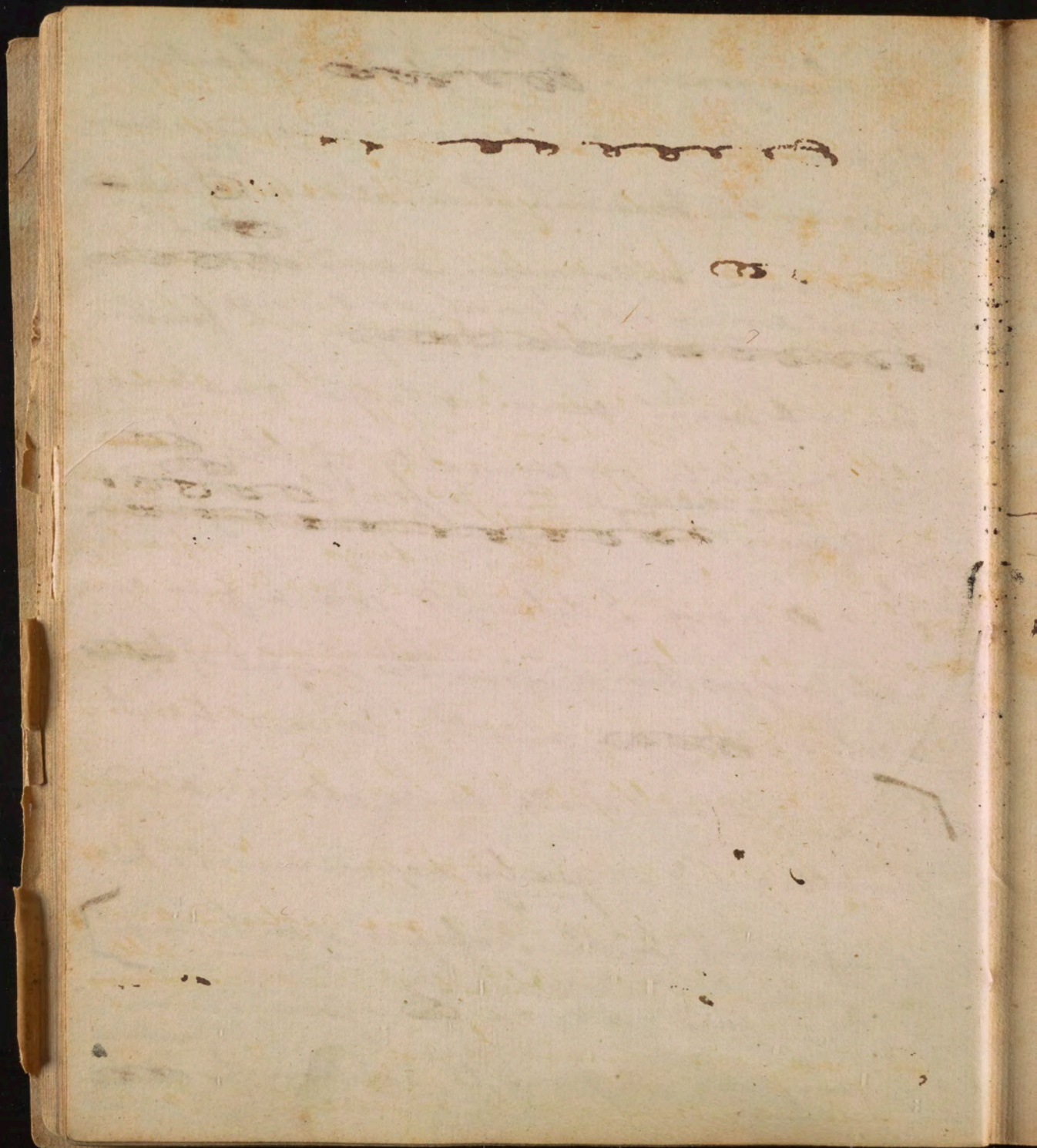
381 They are further  
to this form. ~~which~~ refracted in  
different perpendiculars or directions ac-  
cording as the medium thro' which <sup>they</sup> pass  
is concave, or convex. — and ~~it is~~ they  
meet sooner in a point, or diverge  
~~from a point~~ further  
from a point, according to the greater or  
less concavity or convexity of the ~~medium~~  
thro' which they pass. ~~which~~  
medium ~~which~~

Thus I have delivered you a few gene-  
ral propositions upon the subject of ~~light~~  
& colors, ~~which~~ and the laws of light.

They will be made more plain, and  
intelligible to you by experiments &  
diagrams by the Professor of N. Philosophy.

I have said no more ~~upon~~ upon their  
nature than was necessary to explain the ~~first~~







of vision. -

The application of these facts to vision  
~~On the subject of this subject~~ will now  
 appear simple to you. The rays of light  
~~are~~ fall at all times during the  
 day, in various directions upon the  
 Cornea of the eye. Some of these are  
 reflected back from it - viz: all such as fall on <sup>the membrane</sup> ~~the~~ membrane  
 in a greater angle than  $40^\circ$  - Those which ~~are~~  
 enter <sup>the Cornea</sup> undergo a small refraction in the  
 Cornea - & They undergo <sup>refraction</sup> a still greater <sup>in the</sup>  
 Aqueous humor. - Crystalline lens, - and vitreous humor,  
 and finally they meet in a point or focus  
 upon a small part of the Retina where  
 they paint an image of the Object from  
 which the rays of light are reflected, and  
 which ~~are~~ <sup>is</sup> the Object of vision. ~~being~~ <sup>all</sup>  
 Those rays which the humors of the eye  
 could not concentrate, or refract into a



*[Faint, illegible handwriting throughout the page, likely bleed-through from the reverse side. The text is mirrored and difficult to decipher.]*



383

focus upon the retina are suffocated or  
lost in the black point which lies <sup>upon</sup> the  
vitreous & the ciliary processes. —

---

I have said that the Retina is the  
point in which the visual rays meet in  
a focus so as produce vision. ~~But~~ <sup>I am</sup>  
aware here that <sup>Mariotte</sup> L'etat and <sup>some</sup> many other  
<sup>Physiologists</sup> ~~others~~ place vision in the  
Tunica Choroidæa. The principal argument  
in favor of this opinion is, that the  
B. spot where the optic nerve enters the  
retina has no ~~vision~~ vision, and that  
on that spot, there is <sup>a defect of the</sup> ~~no~~ coat of Choro-  
idæa. But this proves nothing. The Retina  
we know ~~is~~ is a most sensible ner-  
vous medulla, whereas the Choroides  
protrudes but few nerves. ~~The~~ The Retina



V Where the Optic nerve enters it, we find the nerve enters, not in a line with its axis, but near the nose, by which means the picture of no object can fall at the same time on both those insensible parts.

~~The~~ An exact shape in the humors of the eye is necessary to produce just vision. If rays of light are ~~too~~ they become <sup>too</sup> flat, the ~~image of the object~~ brought to a focus beyond the retina, but if these <sup>humors</sup> become too <sup>convex</sup>, the ~~image of the object~~ rays are brought to a focus before they reach the retina. - In both cases vision becomes indistinct. ~~Old men~~ Old men are subject to the former disease of the eye. Children are all born subject to the latter, but it goes off as the eye flattens, which it does as they advance in life. <sup>adult</sup> many persons are subject to it. ~~They~~ They are called myopes. They relieve themselves by holding the object of vision near <sup>to</sup> the eye, or by a concave glasses which prevent the rays of light from meeting in a focus before they



moreover in all animals is as uniform  
 in its shape and properties as vision <sup>itself</sup>  
 whereas there is a great variety in  
 the form of the Choroides in different  
 Animals. <sup>Let any inconvenience should follow</sup>  
 from the insensibility of the ~~the~~ Retina at the Spot <sup>✓</sup>

• The Eye possesses a power of accommodat-  
 -ing itself to near and distant Objects of  
 vision.

This has been supposed to be effected by  
 the projection, or retraction of the Crystal-  
 -line Lens, but more accurate observa-  
 -tions prove that the Lens <sup>is immovably</sup> ~~does not move~~  
 out of its fixed <sup>with</sup> ~~in~~ respect to a forward, or  
 backward motion, and that the <sup>pupil</sup> ~~pupit~~ only  
 is contracted and dilated according to the distance  
 of Objects. It is contracted <sup>in viewing near</sup> ~~in~~ <sup>dilatation & contract</sup>  
 Objects, and vice versa. — This motion in  
 the pupil is produced by the ~~force of the~~ <sup>muscles</sup> ~~of the~~ <sup>of the</sup> ciliary



reach the retina. The persons who have  
flat humors are called Presbyopes. They  
relieve themselves by ~~the~~ placing the  
Object at a greater distance, or by <sup>convex</sup> ~~concave~~  
glasses, which bring the rays of light <sup>to</sup>  
the object of vision on them to a focus before  
they pass the retina. ~~See page 386~~  
It is remarkable <sup>only</sup> that it is which

The Myopes see in the Dark  
only. See page 385

+ This is true in the ordinary state  
of the eye, but Disinvolvement  
= or two cases of internal Dropsy  
of the brain in which the eye  
Contracted with Darknes, & expand-  
= ed with light.



Axis of the Iris becoming <sup>335</sup>straight, or being drawn into  
its in the manner <sup>7</sup>formerly mentioned. 386-1

The pupil moreover contracts & expands  
in proportion to the degree of light thro'  
which it views all objects. — ~~It~~ It  
contracts when we go suddenly into an  
illuminated room, and it expands when  
we leave such a room and go into a  
dark place. The greater the <sup>darkness</sup> ~~darkness~~, the  
greater the expansion of the pupil. <sup>+</sup> The  
light which is necessary for the purposes  
of life is not only relative in different  
animals, but likewise in man; — hence  
we find ~~men~~ <sup>gradually</sup> read of persons who have been  
able to see, and even to read distinctly  
in dungeons where at first they were  
unable to distinguish the <sup>largest</sup> ~~most~~ ~~objects~~  
objects around them. ~~The~~ The sudden

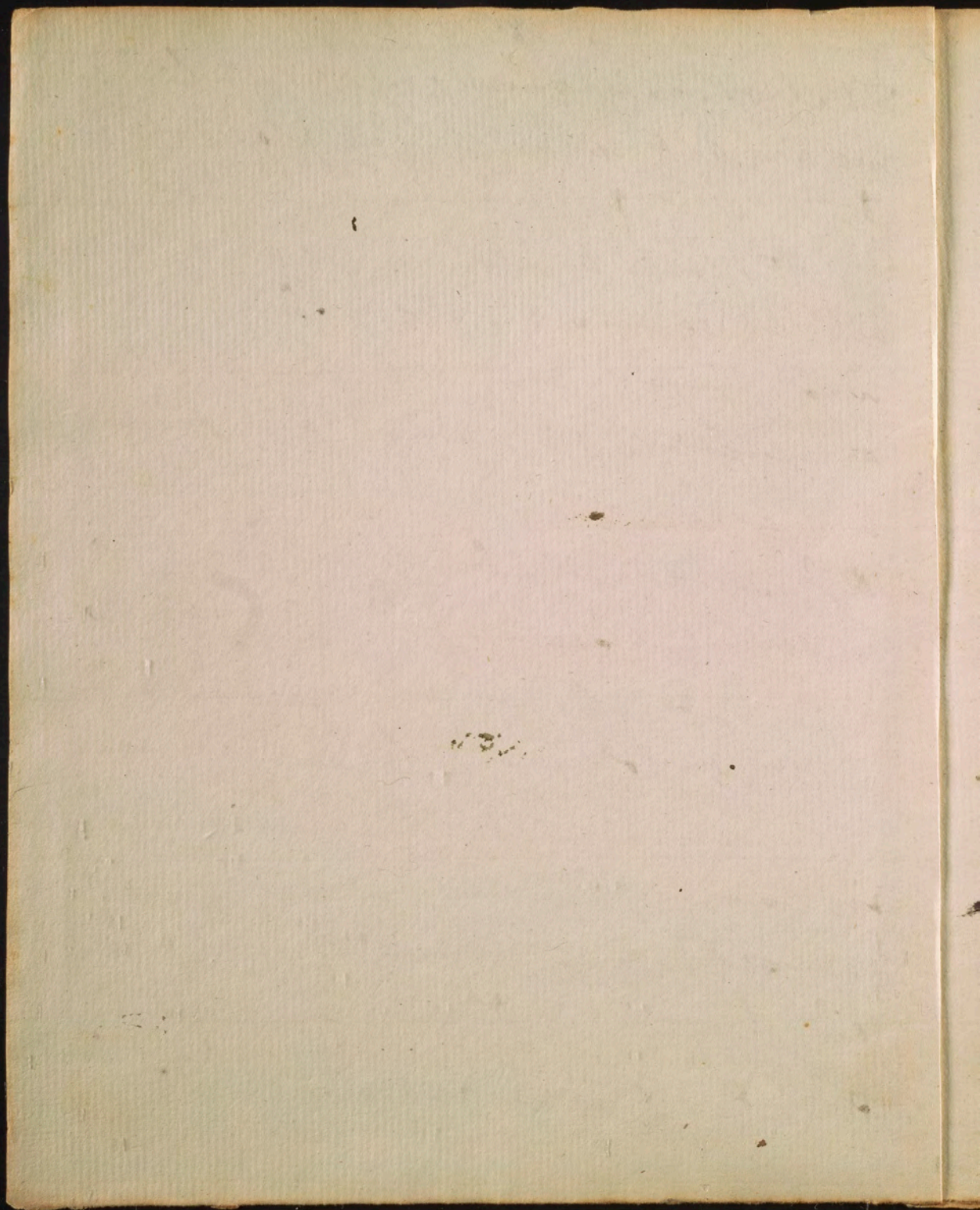


V

That vision is most perfect in which we are able to read a book placed at the distance of one foot from the eyes.

There is another peculiarity in vision which deserves our notice. Some men who possess an apparently perfect eye, are unable to distinguish any, and some but a part of the seven primitive colors. A student in the College of Glasgow could not discover his red gown, when laid upon the green grass. Mr Dalton in the 5<sup>th</sup> volume of the Manchester Memoirs ascribes this peculiarity in vision to the vitreous humor being coloured, so as to absorb some rays, and transmit others. I would rather suppose it was occasioned by a







Disuse in a portion or filament of the nerve which commonly transmits the rays that could not be seen.

Different colors <sup>are induced</sup> by closing & rubbing the eyes. This depends upon the same parts of the retina being stimulated which had been in the habit of producing the ~~same~~ perception of those colors.

Squinting is occasioned by a weakness of the muscles which move the eyes, <sup>It is</sup> <sup>sometimes</sup> induced ~~often~~ by viewing objects sideways. This was the case with the Rev. Mr. Whitefield. His mother when he was a child placed a black patch to cover a little sore upon the side of his nose. By <sup>one of his</sup> ~~his~~ <sup>her</sup> turning ~~his~~ eyes in the direction of that patch



*[Faint, illegible handwriting on aged paper]*

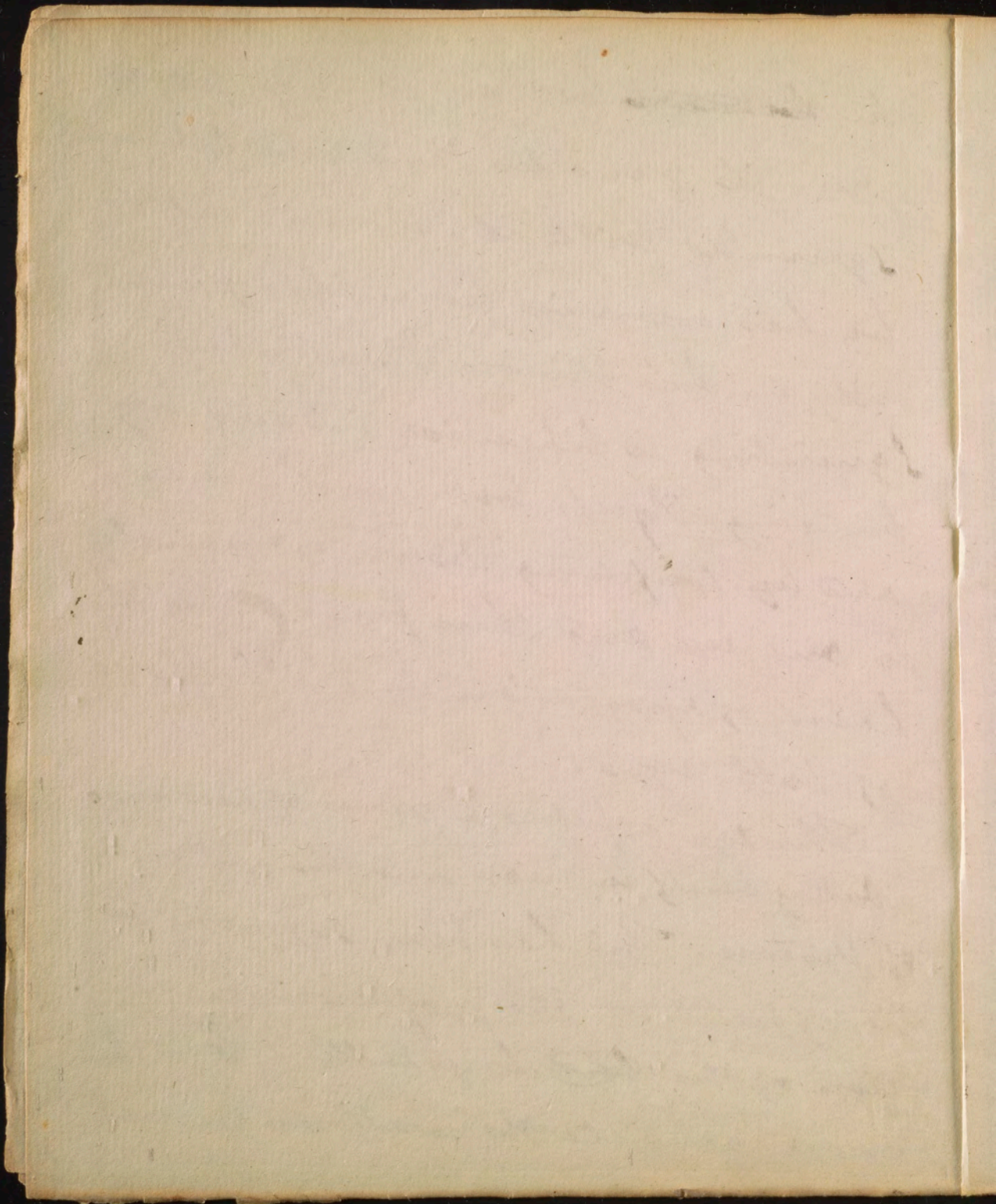
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he ~~lost~~ lost an equal power  
over its muscles, and ever afterwards  
squinted with it. He was called  
by his enemies from this peculiar-  
ity in his Vision *Disquintus*.  
Squinting is likewise induced by  
bringing Objects too near the eyes,  
and by confining Vision exclusively  
to one eye and thus preventing the  
habit of association in the Actions  
of both eyes.

The eye possesses a power of accommo-  
-dating itself to near and distant Objects  
of Vision. This has been supposed to  
be effected by the projection, or retrac-  
-tion of the ~~the~~ Crystalline Lens, but  
more accurate Observations prove

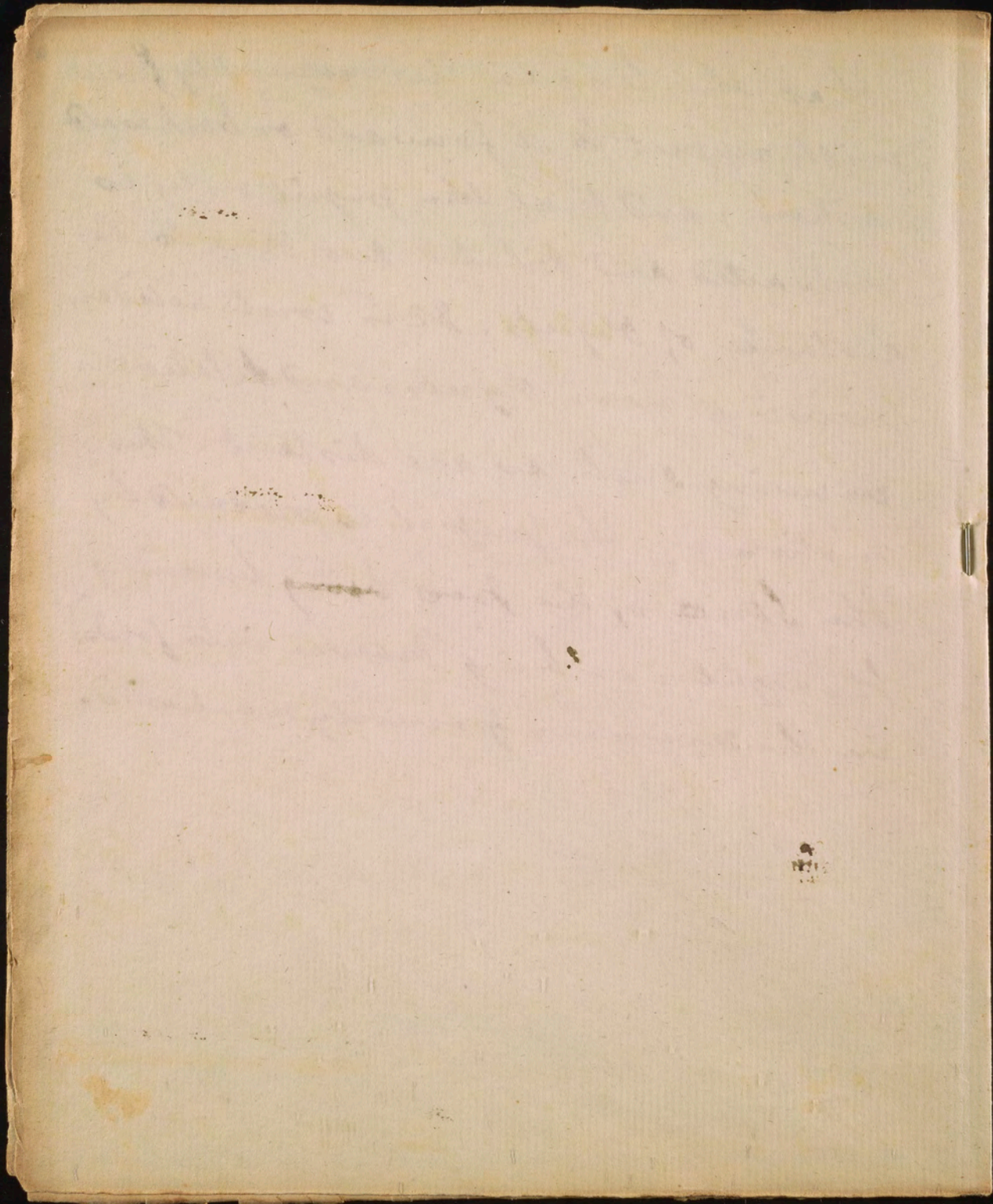






that the lens is immovably fixed  
with respect to a forward or backward  
motion, and that the pupil only is  
contracted and dilated according to the  
distance of objects. It is contracted in  
viewing near objects, and dilated in  
viewing such as are distant. This  
motion in the pupil is produced by  
the Striae of the Iris being becoming  
straight, or being drawn into folds,  
in the manner formerly mentioned.







*Hydrocephalus internus* in which the eye contracted with darkness, and expanded with light. [The case of the same kind but from another cause was once communicated to me by Dr Louché. But again]

‡ There is another peculiarity in visions which deserves our notice. Some men who possess a perfect perception are unable to distinguish <sup>any of</sup> its Colours. & others only a part of the primitive Colours. A student of Glasgow would not discover 10 <sup>habitions</sup> discover them.

In this kind the ~~light enters~~<sup>pupils are</sup> ~~enters~~ by the contraction and dilatation of the pupil. —

his red gown when laid on the green  
grass, except by accident. Mr Dalton in the  
5<sup>th</sup> vol. of the Manchester memoirs ascribes  
it to the vitriolic humor being Coloured,  
so as to absorb some rays & transmit  
Others. I should rather suppose it was owing  
to a disease of the portion or filament of nerve which  
its large base <sup>transmits</sup> the rays that could not be seen. <sup>the turn of p. 384.</sup>  
Commonly <sup>transmission</sup> is occasioned by such a weakness.



impression of light after being long deprived of it, and the sudden abstraction of light, are ~~both~~ both equally unfriendly to the healthy exercise of Vision. It is for this reason probably that the light of the <sup>are</sup> morning, and the darkness of night ~~are~~ let in upon us in a manner so gradual as to give no pain to the eye, & never to injure vision.

All <sup>these</sup> ~~the~~ motions of the Iris & pupil ~~are~~ appear to be instinctive in the human species. But these are under the command of the will in some animals - particularly in the parrot.

<sup>Motions of the pupils</sup> These ~~are~~ are important in certain diseases as they show the state of the



which smoke or fire burning objects  
= in the muscles of the eyes, as that ~~they~~ those  
in a ~~size~~ direction - ~~in~~ white field - or bringing objects too  
of both eyes do not act in concert. It is often  
near the eyes - ~~mis~~ young's daughter found by ~~conspicuous~~  
confined to one eye - from its not being sufficiently  
used in concert with its ~~eye~~ fellow - Return to p 384

~~Infants~~ ~~as~~ ~~for~~ ~~some~~ ~~weeks~~ ~~a~~ ~~power~~  
of moving their eyes only to the right and  
left. ~~They~~ ~~are~~ ~~deaf~~ They are unable to  
look upwards. Their first direction of  
their eyes is generally towards the light.

✓ I formerly spoke of the sympathy between  
the eyes & the stomach. It discovers this  
sympathy ~~is~~ in the action of ~~opium~~  
of opium upon vision. It produces delight-  
-ful or ghastly images according to the  
Dose that has been taken.

Children seldom see correctly until 3 weeks or a month  
after birth owing to the greater thickness of the Cornea,  
& a less quantity of aqueous humor in the eye than is  
proper for vision. The cornea measures  $\frac{1}{8}$  line in a new  
born infant, but  $\frac{1}{4}$  of a line in a grown person. For  
some weeks after birth it can only move its eyes  
to the right and left. It is unable to look upwards.  
~~light~~ Its eyes are first attracted by  
light.



Retina and Brain with respect to sensibility and oppression. They ~~do~~ moreover <sup>contain</sup> ~~the~~ ~~strength~~ <sup>weaknesses</sup> in the <sup>diseases.</sup> ~~System~~ <sup>hence it is generally dilated in chronic</sup> ~~of~~ <sup>particularity</sup> the ~~presence~~ <sup>of</sup> Phthisis pulmon: according to Dr Withering.

It is remarkable that grey or blue eyes are most common in northern, & black or dark coloured eyes most common in Southern countries. A wise reason may be given for this ~~the~~ <sup>difference of color</sup> ~~is~~ <sup>in the eye.</sup> ~~the blue~~ <sup>is</sup> & grey eye ~~is~~ <sup>is</sup> most accommodated to the scanty light of <sup>a</sup> ~~the~~ northern, & the black eye to the redundant rays of a Southern sky. — Were it otherwise, ~~the~~ ~~and~~ imperfect vision or blindness



*[Faint, illegible handwriting, likely bleed-through from the reverse side of the page.]*



would be more universal from the feeble  
 impression  
 of light in the former, & the too pow-  
 erful impression of it in the latter case.

The Indians who inhabit the middle regions  
 of the United States are the only exception  
 that I know to this remark. They have  
 in general black eyes, altho' they live  
 in a <sup>northern</sup> country. But I suspect they  
 are not the Aborigines of the latitudes  
 they now occupy. They appear to ~~be~~  
~~have~~ wandered along the shores of the  
 Mississippi from South America.  
 - The remark therefore will stand good  
 untill we are informed that the Esquimaux  
 Indians, and the nations to the north of  
 them have ~~the same~~ eyes of the  
 same color with the Indians who



have in the world's experience of  
 the power of the pen, a clear  
 and distinct impression.

It is a common, but not all the  
 same, to find in our minds  
 a certain ~~kind~~ of impression.

that of the power of the pen, and  
 of the power of the pen, and  
 of the power of the pen, and

of the power of the pen, and  
 of the power of the pen, and  
 of the power of the pen, and

of the power of the pen, and  
 of the power of the pen, and  
 of the power of the pen, and



live in the middle regions of North America.  
 - I suspect that it will be found that  
 they have the gray, or blue eye of all  
 other northern nations. —

It is a curious fact that all objects  
 are painted in an inverted position on  
 the retina. ~~It~~ <sup>It</sup> has been supposed ~~that~~  
 that objects appear to the mind original-  
 -ly as they are painted on the retina, but  
 that we learn from habit to give  
 them a just position, but this is <sup>an erroneous</sup> false  
<sup>opinion,</sup>  
 for men who have been cured for  
 Cataracts which they had from infancy,  
 see things as we do, ~~that is~~ with  
 respect to position, the instant they  
 receive their sight. <sup>inverted</sup> The position



✓ that are made upon them all.  
We see more distinctly with two  
eyes than =



position is both natural & necessary, for as the mind follows each ray in its course from the part of the retina <sup>wh</sup> is stimulated by it, it places Objects in their true order. The rays which strike the lower part of the eye lead the mind upwards and vice versa. — § 9.

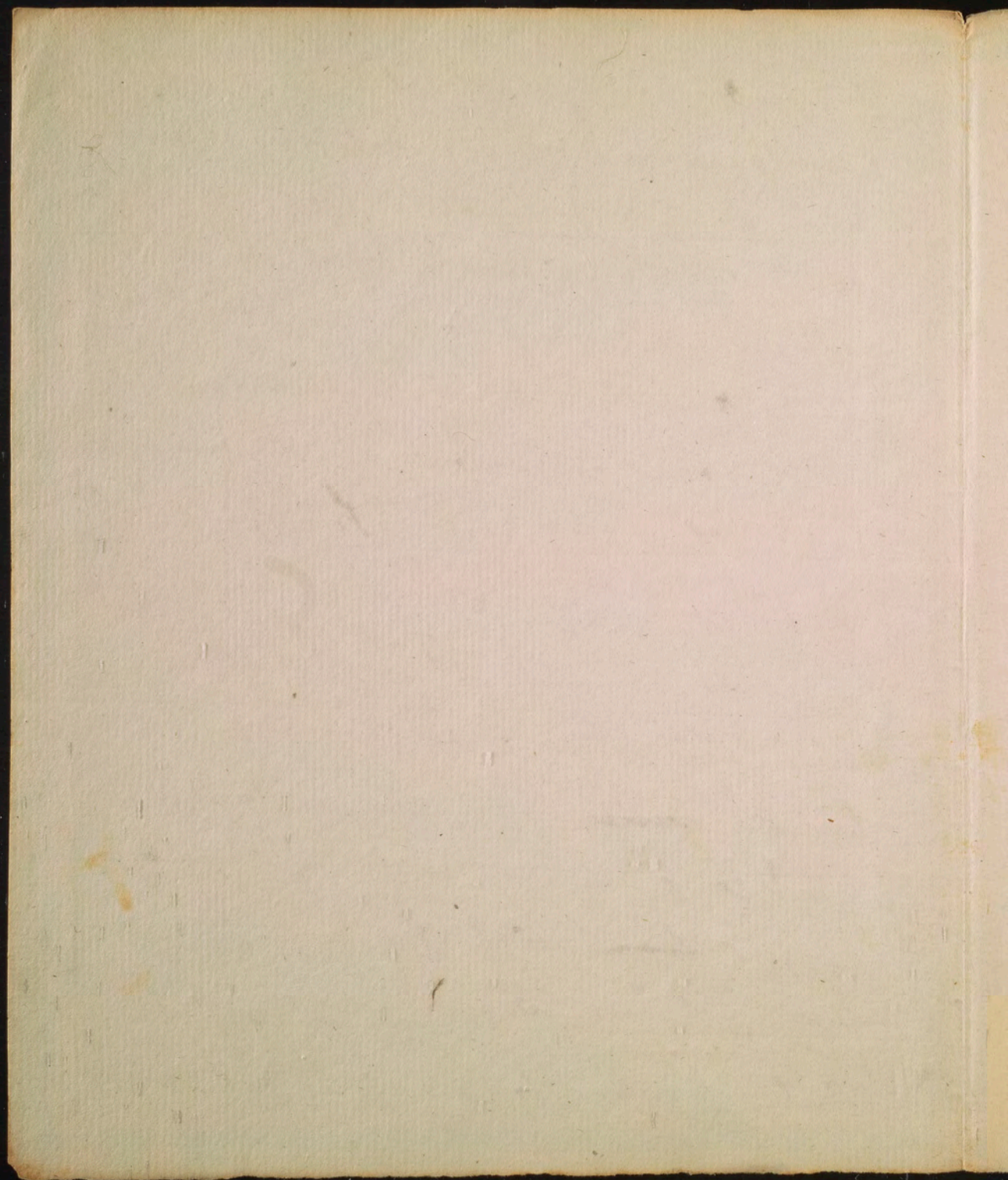
It is equally curious ~~th~~ that with two eyes & two retinas <sup>to</sup> ~~two~~ <sup>an</sup> impressions made on each of them, we see but one Object. This too has been erroneously ascribed to habit. I explain it thus.

From two impressions of equal force, we can have but one sensation. Even <sup>those</sup> insects which have eight eyes, have but one sensation from all the impressions



1  
= with one. The right eye is chiefly employed in Vision. But small as the assistance is which the eyes give to each other,  $\frac{1}{10}$  - to  $\frac{1}{15}$  vision is less true, especially with respect to Distance & Direction with one eye than with two. This is obvious in persons with one eye when they attempt to snuff a candle, or to pour wine into a glass. They generally mistake those Objects, until time and habit have taught them better. ~~but~~ With respect to Acuteness & correctness of Vision, it is more perfect ~~than~~ with one eye, than with both, hence Watchmakers, and Astronomers look with one eye







this their respective glases.

I have several times mentioned the Dependence of the Senses upon each other. Vision owes much to the sense of touch. without it we should be unable to distinguish Distance, figure and motion. This has been proved by many experiments. The young man recently cured by Cheselden imagined every Object he saw touched his eyes. Other persons recently restored to their Sight (who had never seen before) have thought large Objects small, Square Objects round, and moving Objects, stationary. Philosophy therefore confirms the truth of the history of the cure of a man born blind





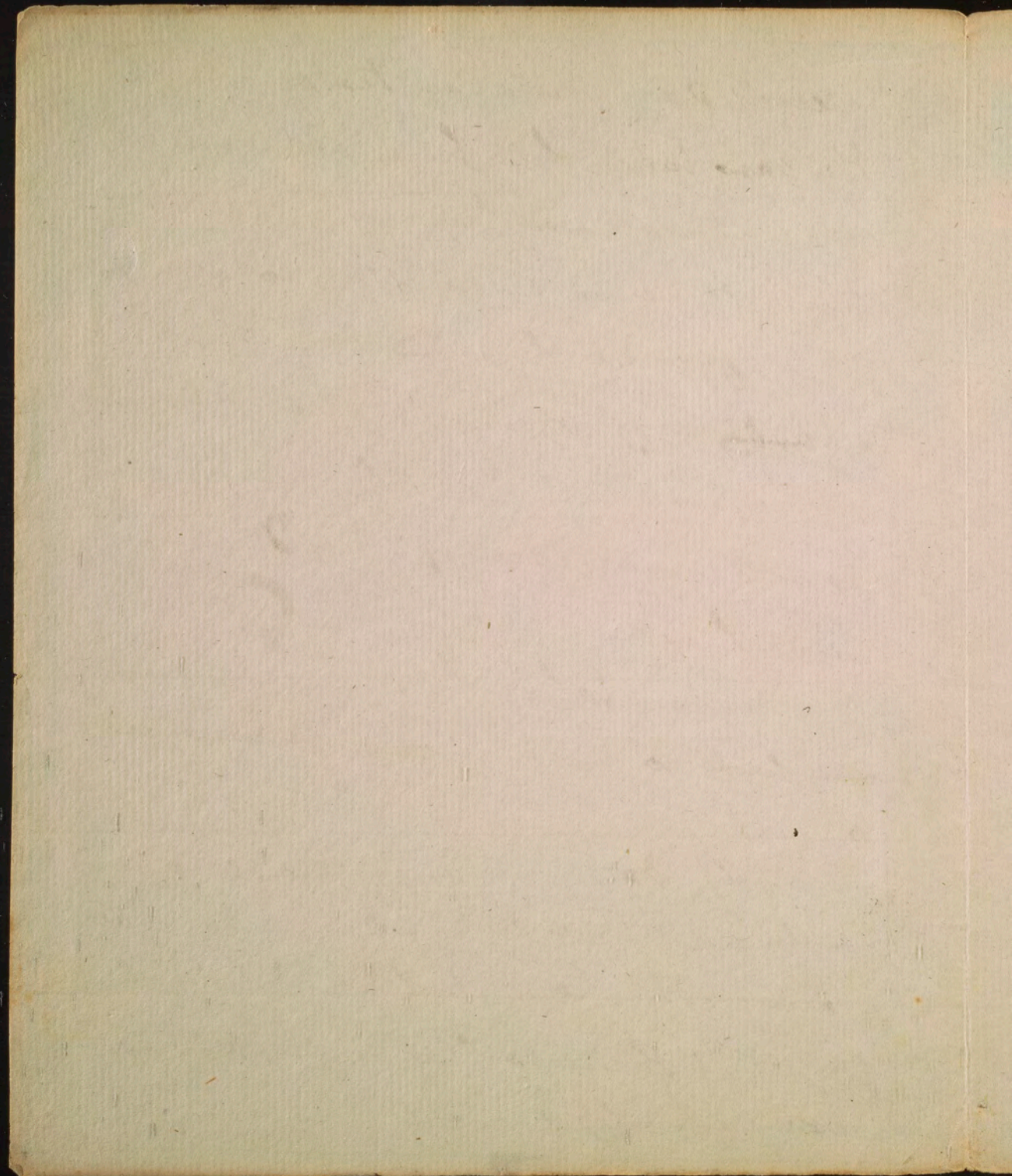


recorded in the new Testament.  
 He saw, when his sight was restored,  
 men - not as they are - but as  
 trees, that is as unlike to men as  
 trees, for he had no doubt when  
 a ~~body~~ boy often handled, & climb-  
 -ed trees, and had thereby formed  
 an obscure idea of their Dimensions  
 and height.

From what has been said we  
 are able to answer the following  
 questions.

Why do some Animals see so per-  
 -fectly in the dark? I answer - be-  
 -cause they have a large dilatable  
 pupil, a shining Choroides, and an  
 exquisitely sensible retina.





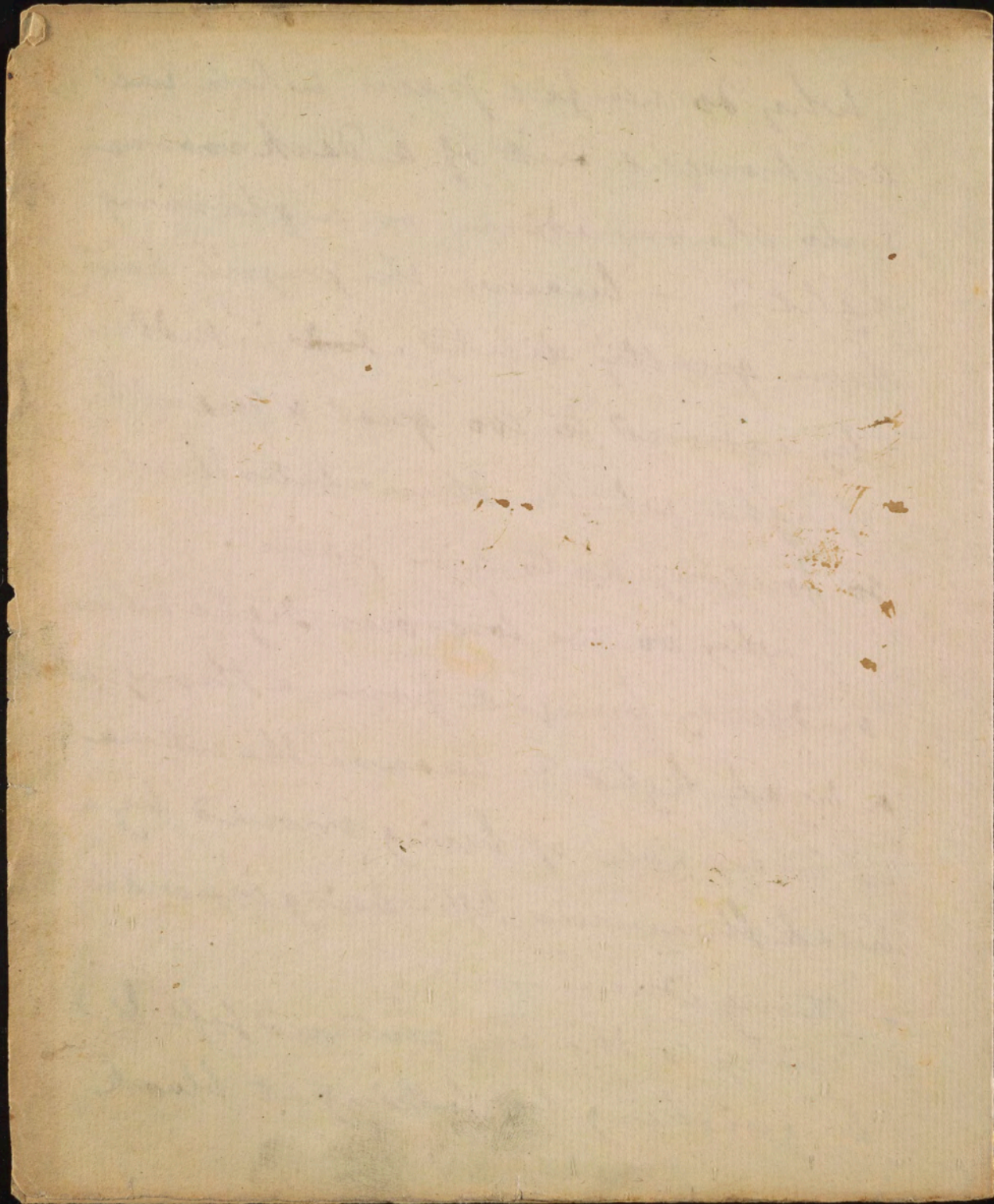


Why do we feel pain when we are brought out of a dark room into the meridian or a glaring light? — because the pupil having been greatly dilated, ~~and~~ is suddenly exposed to too great a quantity of light which stimulates the retina so forcibly as to give pain.

Why do we lose our sight when suddenly brought from a strong to a weak light? because the retina is incapable of being moved by a weak stimulus after being exposed to a strong one. —

Why is the eye rendered soft & sanguiscent by looking at black











0 and never to read <sup>by</sup> ~~by~~ <sup>395</sup> excessive or scanty light - nor to read constantly one kind of print - nor Books printed on very white paper.

3 To avoid pressing the eye in washing the face. It tends to flatten the <sup>hurdness of the</sup> ~~low~~ eyes thereby to lessen sight - by ~~read~~ producing jaundice the disease of Pterygopes. 4 By blacking the eyelids, ~~and~~ or by curling black hair low over the forehead, vision ~~that~~ is improved. Those black matters absorb certain rays, prevent <sup>5th</sup> the eye being overcharged with them. 6 By the early use of Spectacles, as soon as the sight begins to decay! = 1

<sup>5th</sup> # Mr Dose mentions an instance of the sight being improved by the practice of examining the flowers of plants in order to discover their relations to each other. 6 see above #

= 1 7 <sup>2</sup> By reading or writing before day ~~is~~ instead of after light. Lord Ingham and Wm Rawle. Their eyes injured by reading by candle light after night. X



